performance of the reformer is limited by the rate of diffusion of methane to the catalytic surface from the feed gas stream.

[0071] Comparison of the graphs in **Figs. 8** and **9** show that the Rh reforming catalyst provides substantially improved methane conversions as compared to the Pd reforming catalyst, 89-92% vs 74-78%, at close to equilibrium operating conditions, with more consistent conversion, yet the reformer zone using the Rh catalyst operates at the same low temperatures as in the case of Pd catalyst (Ex. 2).

[0072] These examples show that the bicatalytic reactor of the invention can be used to reform methane driving the reaction essentially to chemical equilibrium while keeping reactor temperatures significantly lower than those observed in the prior art. Low temperatures of operation are necessary to insure long catalyst durability. In accord with the invention the reformer zone functions in the temperature of below about 850 °C, and preferably in the range of from about 650 °C to about 800 °C, and most preferably in the range of from about 700 °C to about 775 °C for methane conversion to hydrogen. As compared to the prior art for a wide range of feeds, the temperature drop in the reforming zone is on the order of about 100 – 200 °C. Corresponding improvements in conversion percentages and lowered reforming zone operating temperatures, as well as longer service life will be obtained using other hydrocarbon fuels of the classes listed above. Also, the combination of high-activity combustion and reforming catalyst materials coated on bi-catalyst plates and flow-directing devices provide high local heat and mass transfer rates and high reaction rates that result in a very compact system suitable for use both in stationary and mobile fuel cell power systems.

[0073] It should be understood that the development of the whiskers on the surfaces of the separator platelets is only one example of surface preparation for deposition of the catalyst composition, and both chemical and mechanical treatments can be employed to prepare one or more of the surfaces for good mechanical adhesion and/or chemical bonding (be it coordination, hydrogen, covalent, chelation-

or other type of chemical or quasi-chemical bonding). Thus the surface can be mechanically textured, as by abrading, grinding, embossing, or the like, or chemically etched or pretreated, or chemically/mechanically prepared to accept catalytic composition deposition. The chemical catalysts included within the scope of the invention include the same or different catalyst compositions deposited on the respective obverse surfaces or faces of the platelets, it being understood that in the case of catalyst compositions using one metal or a combination of more than one metal, different ratios of the metals, surface loadings, as-deposited crystallite size, and the like, of the metals as between two compositions are considered to be different compositions. Thus, while the combustion and reforming catalyst compositions may contain the same metal or metals, they can be very different in one or more of the above factors. Further, since the feedstock gases composition supplied to the respective reaction zones may be different, the reactivity and steady state conversion and equilibrium temperatures can vary, even with the same catalyst used for both the combustion and reforming zones.

INDUSTRIAL APPLICABILITY:

[0074] It should be clear that the bicatalytic separator plate modular multi-cell reformer apparatus and methods of the invention will find wide industrial applicability, particularly in association with modular fuel cells and for process chemistry requiring hydrogen rich gas for chemical reactions, such as for polymerization where hydrogen is a reaction modifier. In the fuel cell field, the inventive reformer will find particular use in connection with modular fuel cells used for residential and light industrial power, and for water treatment, such as production of potable water from seawater and other non-potable sources. Use of the modular reformers of the invention in connection with fuel cells for hybrid power sources for mass transit and industrial hauling vehicles is also feasible.

[0075] The invention has been disclosed both by description and by the use of examples. The examples are only exemplary of the principles of the invention and are not intended to limit the invention in any way. It should be understood that various modifications within the scope of this invention can be made by one of ordinary skill in the art without departing from the spirit thereof. It is therefore intended that this invention shall be defined by the scope of the appended claims as broadly as the prior art will permit, and in view of the specification if need be, including equivalents thereof.